UPPER AIR TEMPERATURES.[1]

THIS interesting publication of fifty-eight pages gives an account of some fifty to sixty ascents made at Batavia, Java, and over the neighbouring seas. Batavia lies in the latitude of 5° S., and observations from a place so near the equator are of especial value; these observations also were designed for the purpose of giving information on several interesting points.

The first half of the book gives the detailed account of each ascent, that is to say, the temperature and relative humidity at each 100 metres both on the ascent and descent, and the second half discusses the results obtained. The first point discussed is the thickness of the land wind at night and the temperature inversion. The highest temperature was found at 170 metres, and the depth of the land breeze was 130 metres. The high pressure which prevails over Australia in winter, the winter, that is, of the southern hemisphere, sometimes stretches as far northwards as Batavia, and interesting figures relating to one of these periods are given. Very similar conditions seem to prevail there as in Europe in anticyclonic areas; on rising from the surface, a decrease of temperature with an increasing humidity is met with, but at a height between 2·0 and 3·0 km. excessive dryness with a temperature inversion, or at least a great slackening in the temperature gradient, occurs.

These observations do not depend on kite or balloon observations alone, since the summits of some of the mountains are high enough to give similar records.

In England, the dreary type of anticyclonic cloud that so often covers the sky for days together in winter nearly always, perhaps always, lies just under a sharp inversion of temperature and a layer of excessively dry air, but the height of this inversion seldom reaches 2 km. In Batavia, the cloud layer is replaced by a sheet of moist air in which small cumuli prevail (in the daytime). In both cases the damp and the dry strata are sharply divided, and Dr. Braak discusses the reasons of this arrangement. There cannot be much doubt that the extreme dryness is due to the air having descended from a colder, and therefore dryer, level, dryer, that is, in the sense of having a smaller amount of water vapour; but dry air, as Tyndall pointed out long since, cannot radiate or absorb radiation with any freedom. Probably radiation from the vapour of the damp strata, which can occur freely through the dry air above, has a good deal to do with the formation of the cloud, especially the sea, but they are not numerous enough to show the magnitude with any certainty.

The daily temperature change by day over the sea and the nightly change over the land are also discussed. Dr. Braak finds over the land in the early afternoon a gradient from 0 to 300 m. of 1·34° per 100 m. Over the sea he finds practically no daily change at the sea surface, the amplitude being about one-third of a degree, but the value increases somewhat up to 600 m. The observations suffice to show that there is little daily change of temperature over the sea, but are not numerous enough to show the magnitude with any certainty.

Some interesting remarks are made on the fall of temperature at night, and on an irregularity in the change. The double daily oscillation of the barometer in low latitudes is quite sufficient to produce measurable changes of temperature. It is so commonly stated that the adiabatic change of temperature in air is produced by change of height that one is apt to overlook the fact that change of height by itself is absolutely without effect upon temperature, and that the rise or fall is due to pressure changes only, change of pressure being usually, but by no means always, due to change of height. W. H. Dines.

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[1] "Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia.' Verhandelingen No. 3. Drachen Freiballon- und Fesselballon-berbachtungen. Von Dr. C. Braak. Pp. 58. (Batavia: Javasche Boekhandel en Drukkerij.)

A MANX TRIBUTE TO EDWARD FORBES.

THE London Manx Society has issued a report of the meetings held in London on February 13 to celebrate the centenary of the birth of Edward Forbes. The report ("Edward Forbes, Great Manx Naturalist, Botanist, Geologist, Zoologist," 45 pp., 1*s*.) contains an address by Sir Archibald Geikie, Forbes's biographer, on his life and geological work, appreciations of his zoological work by Prof. Ewart, Prof. McIntosh, and Prof. Herdman, and of his botanical work by Prof. Bottomley; also contributions by Prof. Boyd Dawkins, Mr. Whitaker, and Dr. J. W. Evans, a letter by Mr. Ulrich on behalf of the Palæontological Society of the United States, and the words of Forbes's "Dredging Song." Forbes was born in 1815 in the Isle of Man, and was educated in Edinburgh; in 1841 he was appointed naturalist to H.M.S. *Beacon* during her survey of the Ægean Sea and coasts of Asia Minor. The following year he became Professor of Botany at King's College, which he held, for part of the time, together with the appointments of Palæontologist to the Geological Survey and Lecturer on "Natural History as applied to Geology" at the Royal School of Mines, until his election to the chair of Natural History in Edinburgh in 1854. His death a few months later was, according to Sir Archibald Geikie, "one of the most grievous losses which British science has sustained in our time." His work was remarkable for its wide range, brilliant originality, and philosophic insight. Huxley wrote of him in 1851 that "he has more claims to the title of a philosophic naturalist than any man I know in England." Some of his conclusions on the relations of the British flora to fauna were rejected by his contemporaries and immediate successors, but, according to Prof. McIntosh and Dr. Scharff, they have been established in the main. Mr. E. V. Ulrich, of Washington, reports that Forbes's teaching has "exerted a profound influence on palæontologists the world over," that the principles he enunciated now "assume a commanding importance," and that probably no British author on his subjects has been more followed and quoted in America than Forbes. Forbes was a man of great literary distinction; he was a first-class humorist, and a frequent contributor to *Punch*; and Sir Joseph Hooker has recorded that owing to his talents and his personality "he was beloved and admired beyond any natural historian of his day."

EDUCATION AND INDUSTRY.[1]

I.

THE British Association, by establishing Section L, has recognised education as a branch of science and made provision for its advancement.

But education—I am speaking of that part of it in which human educators intervene—is still regarded as belonging to politics and literature, rather than to economics and physiology. To many people the very title of this paper, "Education and Industry," will appear incongruous. Is there not a great gulf fixed, say they, between hazy views of education high in the clouds above, and the hard facts of science or technology far in the depths beneath?

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[1] Abridged from a paper read to the Educational Science Section (L) of the British Association on September 11, by Principal J. C. Maxwell Garnett.

And yet the intimate relation of education to industry is obvious enough. Of all that goes to make industry possible, let alone prosperous, the human element is the most important. We are careful to select suitable land, we know that capital or credit is essential to us, and we take pains to see that our capital is represented by the most suitable works, machinery, and material. But we commonly take little interest in producing the necessary men to undertake, design, direct, and manipulate the work.

It is true that industry exists for men, not men for industry; and it follows that to train men for industry cannot be the whole end of education. How far the specific training of men for their particular occupations is legitimate can only be decided when we know what the true aim of education really is. Upon the answer to this fundamental question educators are not agreed.

But agreement should not be altogether out of reach if only we would treat education as a natural science. We should then endeavour to keep our thought about education in the closet possible touch with facts, especially physiological facts; we should think and speak, not only of the mind or soul, but also of the cortex of the cerebrum, through which alone the soul can be reached by human educators. When facts are available we should use them, and follow George Eliot's advice not to replace them by metaphors, or mixed metaphors like that of the broad foundation of general culture. When facts are not available we should, if possible, ascertain them by direct experiment; and, if that is not possible, we should have faith—that is, we should ascertain the facts indirectly by acting on an hypothesis with a view to its verification or modification by subsequent experience. That is how progress has been made in other branches of knowledge, and that is how the advancement of the science of education must also be effected. Moreover, the ground so won must be consolidated by the use of some esoteric or symbolic language; for at present our most precise conceptions, being expressed in words that are used every day with many different meanings, receive from each of our hearers or readers a different interpretation.

Consider, for example, the word "character." Perhaps the most generally accepted statement of the aim of education is that of the opening sentence of the introduction to the public elementary school code: "The purpose . . . is to form and strengthen the character. . . ." But this statement fails to produce any clear conception, because it does not define "character," a word which means different things to different people, and which to most people, perhaps, conveys no clear meaning at all. If, however, we reflect that since two men who, when placed in the same circumstances, always did the same thing, would, for practical purposes, be indistinguishable, we realise that men are characterised by their actions: by their fruits they are known. If then we inquire what it is that determines an individual's actions we find—as I have attempted to show in a recent paper [2]—that in addition to the sensory stimuli arising from the environment of the moment, the determining factors are interest, instinct, and will, together with the habits they have helped to form. These, then, are the foundations of character. A further inquiry shows that, if character is to be strong, two conditions must be fulfilled: in the first place, interest must be single and wide, combining the whole range of the individual's experience into one group of inter-associated ideas and including central ideas which strongly move the emotions (instincts); and secondly, the will must co-operate with this single wide interest and its central group of instincts in guiding thought and action.

It follows that if the purpose of education is to form and strengthen character, the proximate aim of education must be to develop a single wide interest—a single complex of inter-connected neurograms.

If the citizens we are educating are to have characters that are not only strong, but also good—that is, if each citizen is to be anxious to serve his neighbours—the emotional element at the heart of his wide interest must be rich in brotherly love. Education without religion is impossible.

If the individual citizens are to be not only anxious, but also able, to serve each other, they must be prepared to divide labour among themselves so as to minister to the economic well-being of the community. The more a man's knowledge or skill differs from that of other people the better in general can he serve his fellow-men. As the occupations of different individuals must differ, and as all the ideas that come to each in the course of his daily work are to form part of his single wide interest, it follows that the single wide interests of different individuals must differ according to their different occupations; and the great interest which each man will then take in his work will incidentally make for his economic efficiency. It is true that these single wide interests must also overlap, so that different individuals may share as far as possible each other's interests and have at least their interest in the State in common. The extent of this overlapping of interests should be limited only by the consideration that during the educand's last two or three years at school—or, if he proceeds to college, then during his university course—his education should have the specific aim of preparing him for his particular work in life, including not only the work for which he is paid, but the whole of what Kim would call his "great game." The need for this application to education of the principle of continuity, so familiar in other branches of natural science, has been thus expressed by the Board of Education's Consultative Committee: "The nearer a pupil is to his entrance into life, the more steadily must the actual practical needs of his occupation be kept in view, and the more decided, therefore, must be the bent of his education to that end." [3]

Finally, education must train the will. The power of the will to focus attention—to direct nerve impulses into a particular system of nervous arcs—is the supreme intellectual faculty, and the only faculty that can be trained. Whoever is to have most creative or abstract thinking to do, most needs this skill in thinking.

II.

These conclusions have been separately proclaimed by several high authorities.

"Milton," said Prof. Perry last year from the presidential chair of this section, "taught me the true notion of education, that the greatest mistake is in teaching subjects in water-tight compartments" [4]; in fact, education must aim at building up a *single* wide interest.

"Thorough knowledge of one subject and practice in it," said Goethe, "produces higher culture than incomplete knowledge of a hundred subjects." [5]

Ruskin had no doubt about the need for specific education. "The idea," he wrote, "of a general education that is to fit everybody to be Emperor of Russia . . . is the most entirely and directly diabolical of all the countless stupidities into which the British nation has of late been betrayed." [6]

"The whole evolution of educational theory," according to Prof. Adams, "may be said to be a great sweep from specific education back to specific education, through a long period during which formal training held the field."[7]

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[2] Published in *Manual Training* for May, 1915.

[3] Report on Higher Elementary Schools (1906), p. 11.

[4] NATURE, October 1, 1914.

[5] Quoted by Dr. Kerschensteiner, "Schools and the Nation," p. 256.

[6] "Fors Clavigera," p. 254.

Finally, William James maintained that "The faculty of voluntarily bringing back a wandering attention over and over again, is the very root of judgment, character, and will. . . . An education which should improve this faculty would be the education *par excellence*."[8]

III.

We shall now assume the truth of these conclusions and proceed to discuss the problem of so educating every individual that he shall possess, in the first place, the single wide interest which his particular service to the community most needs for its efficiency; and secondly, skill in thinking—the capacity of voluntarily focusing his attention.

We have first to investigate the qualities—the type of single wide interest and the degree of skill in thinking—required by those who are to be engaged in various classes of industrial occupation; and afterwards to indicate a means of developing the required qualities in a sufficient number of persons, selected on account of their innate aptitudes for each different kind of work.

The first classification to suggest itself is that of the various branches of industry, such as engineering, building, chemical manufacture, the textile industry, and the like. But the qualities required in the manager of an engineering works have more in common with those needed by the manager of a chemical works or of a cotton mill than with the qualities sought for in the lowest grades of labour employed in any of these industries. In the same way the designer of electrical machinery will generally have more in common with the professional physicist than he has with the engineering tradesman who makes what he designs.

We shall find it convenient to adopt the following classification :—

Class A.—Industrial statesmen; chief designers; research engineers, chemists, etc.; consulting engineers, etc.

Class B.—Works managers and heads of departments; junior members of designing, testing, and managerial staff.

Class C.—Foremen and leading hands; skilled tradesmen.

Class D.—Machinemen and repetition workers; unskilled labourers.

No essential discontinuities are to be imagined between these classes; nor are the occupations named to be regarded as forming complete lists of the classes of work they are intended to indicate.

We have already remarked that every occupation includes that of citizen. We have next to consider the special, or distinguishing, features of each different class of occupation.

It is clear that each class is concerned, in the course of daily work, with a greater *variety* of ideas than the class next below it. Accordingly, trains of thought of members of class A must on the average be fresher, and therefore less governed by habit, than those of members of classes B, C, or D. "The controllers of the great industry," writes Mr. Graham Wallas, "are always on the look out for that type of man whom Americans call 'a live wire.' For such a man secretaries and typists and foremen carry on all that punctual performance of habitual acts which took up so much of the time and labour of a merchant or manufacturer even fifty years ago. He is set to form a habit of non-habituation. . . ."[9] Such a man requires more emotional drive than one who is engaged in mere routine work. And since his ideas cover so wide a range, they are not so naturally associated together as those which their daily work brings to members of classes B or C or D. He therefore needs to weld his various ideas into a single wide interest by making voluntary associations between them; and in order to make such associations, especially between dissimilar ideas, he needs skill in thinking.

So, then, class A requires a wider interest, a stronger emotional element in that interest, and more skill in thinking—but not necessarily more pay—than class B, class B than class C, and class C than class D.

Let us now look more closely at each of these classes. The first named on our list is that of the industrial statesman. We know him already as the captain of industry. But he has lately changed his name, for the title of captain does not indicate with sufficient clearness the fact that the head of a great industrial firm must needs concern himself with much that is happening outside the establishments which he controls. Not only must he be familiar with the state of the markets from which he draws his supplies and in which he disposes of his products, but, by grasping the significance of economic, social, and political changes all over the world, he must be able to foresee opportunities for developing his business according to a far-reaching policy, and to indicate the lines of technological research which are most likely to lead to such developments. Work of this kind involves the widest sort of knowledge. But beware of the professional administrator who is prepared to administer anything at a moment's notice. The statesman—whether industrial or not—must possess, in addition to a wide range of knowledge and much skill in thinking, a very special interest in the particular concern he is directing, whether that concern is his own small business or an empire the destinies of which are under his control. He must see that concern as a whole, and must love it. "Without passion," said Lord Haldane to the students of Edinburgh University, "nothing great is, or ever has been, accomplished."[10]

Lord Haldane went on to compare the statesman with the expert, greatly to the latter's disadvantage. Much that has happened lately would probably cause Lord Haldane to express himself differently now. In any case we shall not follow him here. We shall instead place the expert in the same class as the industrial statesman because the former requires an equally high degree of skill in thinking and at least as complex (if not so widely varied or so emotional) an interest as the latter. The industrial statesman may be compared to the astronomer who uses the telescope to increase his grasp of the whole, while the expert rather resembles the naturalist whose microscope enables him to see the parts in great detail. It is evident that the successful development of industry demands not only the expert in special branches of science or technology, but also the industrial statesman who co-ordinates the work of experts in different fields, and who is himself enough of a specialist fully to understand his experts, to command their confidence, and, when necessary, to decide between them. Whoever has authority must also have knowledge.

The members of class B require fewer associations to connect the ideas which constitute their single wide interests. They need less skill in thinking than members of class A. They require, on the other hand, a very wide descriptive knowledge of material things, and as much of this knowledge as possible they should have acquired at first hand from direct sense impressions. Last, but by no means least, the works manager and his immediate assistants need to interest themselves in the social and economic welfare—including the further education, recreation, and housing—of all their employees, and this interest will help to form the nucleus of those single wide interests which are to include all the activities of members of class B.

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[7] "Evolution of Educational Theory," p. 225.

[8] "Principles of Psychology," vol. ii., p. 424.

[9] "The Great Society," p. 87.

[10] "The Conduct of Life," p. 25.

Foremen and leading hands have hitherto been generally recruited from among skilled tradesmen. They are therefore presumed to be qualified themselves to perform every task they have to supervise, and even to perform it better than the men who are actually doing the work. Upon this presumption is based the claim that the shop foreman must be paid a higher wage than any workman under him. This view, accepted as it generally is by employers and employed alike, is responsible for no small restriction of output. But it is based on a misconception, since the foreman is paid for supervising men, and the workman for manipulating material—two quite incommensurate processes. There are, however, signs of change. Technically trained foremen whose wages may (to start with) be much less than those of the men they have to look after, are already being employed, especially in shops where much repetition work is done. Yet it remains true that the qualities now most sought for in foremen and leading hands are those of the craftsman whose interest is centred in his manual work.

The operative skilled tradesman whom, for this reason, we have placed in the same class as his foreman is distinguished from the machine man in class D in that the operative in class C has a *variety* of skilled work to do, while the members of class D who may do skilled work, *repeat* the same process over and over again until its performance is governed by habit, so that it almost ceases to receive attention. On the one hand, ideas connected with *doing*, like ideas associated with a strong instinct, are peculiarly liable to receive attention, so that the work of the skilled tradesman in class C is well able to form a strong centre for his single wide interest. On the other hand, ideas connected with the repetition work of class D tend to become circumscribed and cut off from other interests. There is, however, reason to believe that repetition work is not altogether uninteresting to a certain type of mind. It is, indeed, actually preferred by some people, including many women. Such work may, therefore, form a substantial, if not a dominant, part of an interest that is not rich in exciting ideas. The remaining part of the single wide interest is of special importance in the case of class D. When an eight-hours day is universal it may be that the artisan or labourer who leaves work with much of his day still before him and feeling pleasantly exercised rather than unduly tired by his somewhat monotonous but by no means exacting labour, will devote himself increasingly to national and municipal affairs. With that end in view we must see to it that the average member of class D receives —not only in maturity through the Workers' Educational Association, but also in youth through vocational part-time classes—the kind of training which shall best develop a single interest, wide enough to include the highest ideals of patriotism as well as loyalty to a particular industrial class.

IV.

We have next to consider how to develop in a sufficient number of suitably selected persons the qualities which we have indicated as specially needed in each class of industrial occupation.

Childhood up to, say, twelve years of age has few organised interests. Accordingly, the need for a coherent curriculum, aiming at developing a single wide interest, does not obtrude itself until adolescence begins. The future member of classes A and B will normally spend much of his adolescence in a secondary school. Of these schools it is convenient to distinguish two types, named "Higher" and "Lower" respectively in the accompanying diagram.

The chief function of the secondary school, the school for adolescents, is to foster the growth of true religion—"not theology nor yet ethics, but personal and experimenetal[11]—and around this centre to build up, out of the miscellaneous information obtained in childhood and the coherent curriculum which the secondary school should itself provide, the beginnings of that single wide interest which should continue to grow throughout maturity. The skill in thinking which the secondary school must also cultivate is best practised upon a number of closely associated ideas—a coherent interest—because, unless the idea before consciousness at any moment calls up *many* others, from which the will can select that which is next to receive attention, this faculty cannot be practised; and without practice skill in thinking cannot be developed.

The broad foundation metaphor, of which Dr. Kerschensteiner[12] has made such fine fun, is probably responsible for the fact that most secondary schools aim in theory, and some lower secondary schools (unfortunately) in practice also, at comprehensiveness rather than at coherence of interest: they have failed to realise that coherence at seventeen is the surest way to comprehensiveness at twenty-seven. Concentration has, however, been practised by the classical sides of English public schools. But in many of the newer secondary schools six or seven distinct subjects are taught out of all relation to one another by as many separate specialists, and the form master himself is almost unknown!

The future member of class A should remain at his higher secondary school and enter the university at, or soon after, the age of eighteen. It is true that the future engineer often spends some time in works between school and college; but there is a growing consensus of opinion that this period should not be too long. Perhaps from Christmas until the following October would be ideal if both school-leaving and university-entrance scholarships could be awarded, as those of some Oxford and Cambridge colleges already are, just before Christmas.

It is to the university that we shall principally look in the future for an essential part of the specific training of members of class A, for the men with creative minds, inventors of new appliances and processes, men who shall not merely be able to follow existing practice but also to cope with new problems and even to lead in new lines of advance. And our university courses, if they succeed in producing men of this type, will do so, not because of the knowledge they impart, wide though it be, but because of the stress they lay on the acquisition of skill in thinking along with knowledge. It is skill in thinking—skill in applying old knowledge to new situations—rather than knowledge itself without such skill, that now, as always, marks the really practical man. If, in fact, his university course can, in Huxley's phrase, give him "real, precise, thorough, and practical knowledge of fundamentals," the candidate for membership of class A may well wait for subsequent works experience, post-graduate evening classes, and private reading, to develop further his *technical* information to a marketable standard. Whatever letters he may be able to write after his name, his undergraduate course should have aimed at making him a bachelor of arts, skilled in the art of learning, and only incidentally have given him a body of scientific knowledge capable of immediate application.

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[11] G. Stanley Hall, "Adolescence," vol. ii., p. 326.

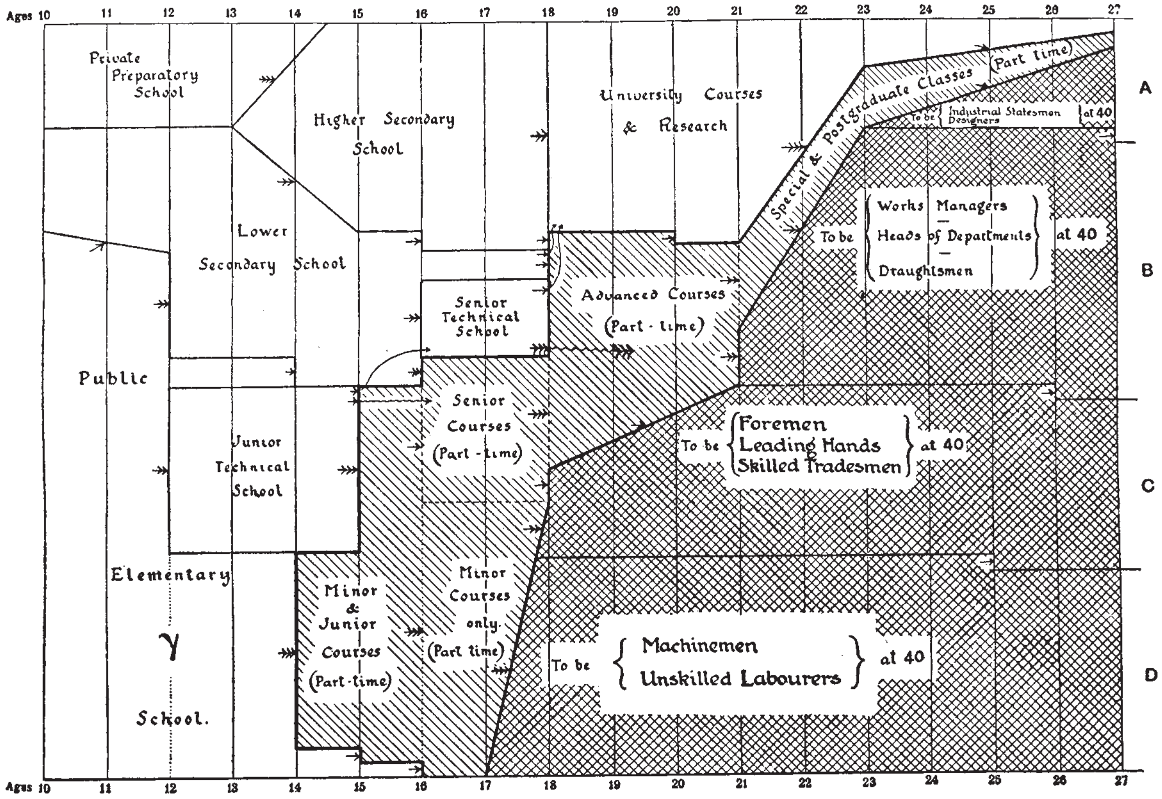
[12] "Schools and the Nation," p. 275.

This view of the chief aim of a university course insists that there shall not be overmuch lecturing; that information shall be acquired because it is immediately and urgently needed for the solution of some practical problem; that a larger proportion of the most able students shall remain "up" after taking their degrees for the purpose of undertaking original research; and that, while the most distinguished professors shall take part in the teaching of the undergraduates from the outset, they shall do so, not because of the knowledge they are peculiarly able to impart, but because "the personal influence of the man doing original work in his subject inspires belief in it, awakens enthusiasm, and gains disciples." [13]

In urging that the chief aim of a university course must be to cultivate skill in thinking rather than to impart information, we do not mean that such a course must be at all detached from practical things. It is no more possible to develop skill in thinking without knowledge than to acquire skill in the use of tools without material to work upon. Technical knowledge is, in fact, a most excellent foundation and medium for cultivating skill in thinking.

England is fortunate in that most of her highest study and research in technology form part of the work of her universities. For a university is more than a university course or an aggregate of such courses. The opportunities which a university affords for studying elective subjects are important. But far more important is the intimate and constant association in the various students' societies, as well as in the lecture rooms, drawing offices, or laboratories, between students in different faculties, from different countries, and with entirely different outlooks.[14]

But the State cannot afford to provide a university training for all its citizens. The majority, even of class B, will be compelled by economic pressure to begin earning money before they are twenty years


Ages 10
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Private Preparatory School
Higher Secondary School
University Courses & Research
Special & Postgraduate Classes
(Part time)
To be {Industrial Statesmen Designers} at 40
A
Lower Secondary School
Senior Technical School
Advanced Courses (Part-time)
To be {Works Managers — Heads of Departments — Draughtsmen} at 40
B
Public Elementary γ School.
Junior Technical School
Senior Courses (Part-time)
To be {Foremen Leading Hands Skilled Tradesmen} at 40
C
Minor & Junior Courses (Part-time)
Minor Courses only. (Part time)
To be {Machinemen Unskilled Labourers} at 40
D

EDUCATION AND INDUSTRY.

Diagram illustrating proposed modification of present organisation.

HORIZONTAL SCALE: The spaces between adjacent vertical lines represent one year.

VERTICAL SCALE: The vertical scale increases from the bottom of the diagram to the top. The intercept made on any ordinate by the enclosed area which corresponds to any course varies with (but not strictly in proportion to) the number of students of the corresponding age who should be following the course in question.

—>>> the great majority of the - - - -
—>> indicates that a constant supply of systematically selected
—> a few exceptional - - - - - -
persons leaving the course which corresponds to the area in which the arrow-head lies should proceed to the course towards which it points.

The unshaded portion of the diagram is concerned with "full-time" education; that is, with schools and classes meeting in the daytime and occupying all the working hours of those by whom they are attended. The central singly shaded area relates to part-time classes: classes meeting either in the day or in the evening, and intended for persons whose employment occupies the greater part of their time. The doubly shaded region on the right of the diagram corresponds to those later years of industrial practice when a man has ceased to attend organised courses of study bearing upon his trade or profession.

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[13] Final Report of the Royal Commission on University Education in London, p. 29.

[14] See Newman's eloquent words quoted by the Royal Commission on University Education in London (*loc. cit.*, pp. 26, 27).

old. Where a suitable senior technical school exists, they will do well to receive in it the specific training which should occupy the last two years before their entry into industrial life. The very important place which a senior technical school should fill in the educational system of an industrial district is, as yet, hardly realised.

The future member of class C should be transferred from the public elementary school to the junior technical school when other children are transferred to the lower secondary school. The junior technical school should prepare him for entering one of a group of allied trades at or about the age of fifteen. It is not, however, the function of the junior technical school to teach him a trade, but rather to develop his manual skill in work that is closely related to that of the trade to which he is looking forward, and to extend the great interest which he cannot help feeling in such work so as also to include so-called "general" subjects. Experience has shown that he will thus make more progress in these "general" subjects than if he were studying them in a school which has no specific aim.

When the future members of classes A, B, and C have been transferred from the public elementary schools at the age of twelve, the work of the future members of class D who are left behind should differ[15] somewhat from the general work done by all children below the age of twelve. It might well be centred in (but not, of course, be confined to) handwork during these last two years, and so have much in common with the training of Boy Scouts.

Even when the last two years of whole-time education have been admirably adapted to prepare the educand for his imminent vocation, some educational discontinuity must always occur as he leaves whole-time school or college to continue his education in industrial life. Part-time classes afford the best means of reducing this discontinuity to a minimum. Accordingly, every boy or man, as he first enters upon industrial work, should attend suitable part-time classes. No feature of English education is more striking to the foreign observer than the system of part-time courses in all our great centres of industry. At the present time most part-time courses involve attendance on three evenings a week for several successive years. Although they cannot cover the whole ground of university courses, they aim (for the most part) at affording an alternative means of training men to occupy positions of responsibility in industrial affairs.

While, however, our part-time classes are thus training technical men, they are neglecting manual workers. Instead of attending these technical classes, the boy who enters works at fourteen or fifteen years of age requires (at least until he is seventeen years old) a special type of part-time course, to which the name "minor course" has lately been given. One of the principal objects of such a course is to provide instruction in those matters which the trade apprentice in bygone days learned by close association with a master craftsman, and which are commonly lost to him under modern industrial conditions. The minor course will therefore "have as its central subject the trade processes or craft in which the students are engaged."[16] But so-called "citizenship" subjects—such as history and economics, the study of which will make for a better understanding of problems concerning wages and hours of labour—also form an essential part of a minor course. It remains to add that the need for minor courses is not yet sufficiently appreciated, with the result that a great opportunity of educating during the critical years of adolescence the numerous members of class C and class D is being neglected.

V.

The system of education, the outline of which I have thus described, is represented on paper in the diagram. Its realisation in any English industrial district—say Manchester—would need some, but not much, co-ordination; for the diagram represents neither what is nor what might be under ideal conditions, but what could be made out of what is with the maximum of advantage in proportion to the effort spent in making the change. The co-operation of local education authorities, universities, the Government, employers, and parents would be required in order to complete this change.

But already there are signs that all the necessary co-operation is forthcoming. Many striking instances might be cited in support of this statement did time permit. I must, however, be content to mention only two: Mr. Henderson's new scheme for the organisation and development of industrial research, and a similar scheme recently prepared by a committee of the Manchester Engineers' Club. This latter scheme provides for organised co-operation between schools, colleges, and engineering firms in the education of engineers and for the encouragement of research in the following, among other ways:—

> By developing co-operation between engineering firms on the one hand and universities and technical colleges on the other, so as to establish such "schools of thought" as exist in the research departments of great Continental and American engineering firms, but cannot be fostered in the comparatively small establishments (and smaller research departments) of most British engineering firms.

VI.

The co-ordinated system of schools, colleges, and works represented in the diagram will not be satisfactory unless it is thoroughly democratic. It is true that innate differences between individuals cannot well be distinguished from differences produced by home surroundings. But whoever is best fitted by nature and nurture for any particular class of occupation should be selected to receive, if necessary at the State's expense, the training which will best prepare him for it. Education authorities should see that the number of persons so selected is sufficient—but not much more than sufficient—to supply whatever demand is also a need.

VII.

At present the supply of men for the highest classes of work falls very far short of the demand. Every year the number of appointments offered to School of Technology graduates greatly exceeds the number of these graduates. Not only is this true of posts in chemical works, but also of electrical and other engineering appointments. Although the number of undergraduates in the School of Technology (Faculty of Technology in Manchester University) increased by 50 per cent. in the two years before the war, the demand for their services after graduation increased in a still larger proportion.

Such facts need to be realised by boys and by their parents. But it is even more important that they should realise that the highest kind of technological work is noble work, worthy of a lifetime's duration. The profession of applying science to industry is rich in opportunities for helping to bring about the ideal future of the human race. While it is the glory of the medical profession, for example, that it assists in preventing a wastage of life that could not but retard human progress, we must remember that technology helps to produce what medicine and surgery help to preserve. The great increase in population which began in the middle of the eighteenth century was directly due to mechanical invention. Indeed, the application of science to industry not only renders possible a rapid growth of population, but it exempts an ever-growing proportion of this increasing population from the need for incessant physical toil. Moreover, all that acceleration of human progress which results from the increasing national expenditure on the education of the people would cease with any interruption of the march of technological invention.

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[15] The difference is marked by the dotted line at γ in the diagram.

[16] Board of Education Circular 894.

Every improvement, then, which the technologist may be able to make in the direction of cheapening production—reducing, for example, the cost of a brake horse-power hour—will help to increase the number of men whom the community can spare for the study of classical literature in order to keep the thought of our time in touch with the best of the thought of ancient Greece and Rome; it will help to increase, too, the number of those who can be spared by this generation to devote their lives to scientific research, to widen the scope of human thought, to teach men more of the works and ways of God, and to obtain the knowledge which technologists of the future will apply for the benefit of generations not yet born; and, most important of all, it will help to support the seers and the prophets on whom we so largely depend in the weightiest affairs of human life.

THE BRITISH ASSOCIATION.

SECTION M.

AGRICULTURE.

OPENING ADDRESS BY R. H. REW,[1] C.B., PRESIDENT OF THE SECTION.

Farming and Food Supplies in Time of War.

BEFORE considering the position of farming in the present war, we may briefly glance at its position when a century ago the nation was similarly engaged in a vital struggle.

From February, 1793, until 1815, with two brief intervals, we were at war, and the conflict embraced not only practically all Europe but America as well. The latter half of the eighteenth century had witnessed a revolution of British agriculture. The work of Jethro Tull, "Turnip" Townshend, Robert Bakewell, and their disciples, had established the principles of modern farming. Coke of Holkham had begun his missionary work; Arthur Young was preaching the gospel of progress; and in 1803 Humphry Davy delivered his epoch-making lectures on agricultural chemistry. Common-field cultivation, with all its hindrances to progress, was rapidly being extinguished, accelerated by the General Inclosure Act of 1801. A general idea of the state of agriculture may be obtained from the estimates made by W. T. Comber of the area in England and Wales under different crops in 1808. There were then no official returns, which, indeed, were not started until 1866; but these estimates have been generally accepted as approximately accurate, and are at any rate the nearest approach we have to definite information.

I give for comparison the figures from the agricultural returns of 1914, which approximately correspond to those of the earlier date:—

	1808 Acres	1914 Acres
Wheat	3,160,000	1,807,498
Barley and rye	861,000	1,558,670
Oats and beans	2,872,000	2,223,642
Clover, rye-grass, etc.	1,149,000	2,558,735
Roots and cabbages cultivated by the plough...	1,150,000	2,077,487
Fallow	2,297,000	340,737
Hop grounds	36,000	36,661
Land depastured by cattle ...	17,479,000	16,115,750

The returns in 1914 comprise a larger variety of crops than were cultivated in 1808. Potatoes, for instance, were then only just beginning to be grown as a field-crop, and I have included them, together with Kohl-rabi and rape, among "roots and cabbages."

The population of England and Wales in 1801 was 8,892,536, so that there were 35½ acres under wheat for every hundred inhabitants. In 1914 the population was 37,302,983, and for every hundred inhabitants there were 5 acres under wheat.

The yield of wheat during the twenty years ending 1795 was estimated at 3 qr. per acre[2]; in 1914 it was 4 qr. per acre. The quantity of home-grown wheat per head of population was therefore 8½ bushels in 1808, and 1½ bushels in 1914. Nevertheless, even at that time, the country was not self-supporting in breadstuffs. In 1810, 1,305,000 qr. of wheat and 473,000 cwt. of flour were imported. The average annual imports of wheat from 1801 to 1810 were 601,000 qr., and from 1811 to 1820 458,000 qr. Up to the last decade of the eighteenth century England was an exporting rather than an importing country, and bounties on exports were offered when prices were low, from 1689 to 1814, though none were, in fact, paid after 1792.

During the war period we are considering, the annual average price of wheat ranged from 49*s*. 3*d*. per qr. in 1793 to 126*s*. 6*d*. per qr. in 1812; the real price in the latter year, owing to the depreciation of the currency, being not more than 100*s*. In 1814 the nominal price was 74*s*. 4*d*. and the real price not more than 54*s*. per qr.[3] The extent to which these high and widely varying prices were affected by the European war has been the subject of controversy. As we mainly depended on the Continent for any addition to our own resources, the diminished production during the earlier years in the Netherlands, Germany, and Italy, and in the later years of the war in Russia, Poland, Prussia, Saxony, and the Peninsula, reduced possible supplies. At the same time the rates of freight and insurance, especially in the later years of the war, increased very considerably. Tooke mentions a freight of 30*l*. per ton on hemp from St. Petersburg in 1809. On the other hand, a powerful impetus was given to home production, which was stimulated by Government action and private enterprise. Inclosure was encouraged by the General Inclosure Act of 1801, and 1934 Inclosure Acts were passed from 1793 to 1815. The schemes for increasing and conserving food supplies were various. The Board of Agriculture, for example, offered prizes of 50, 30, and 20 guineas respectively to the persons who in the spring of 1805 cultivated the greatest number of acres—not fewer than 20—of spring wheat.[4] In 1795 a Select Committee recommended that bounties should be granted to encourage the cultivation of potatoes on

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[1] Slightly abridged by the author.

[2] Report of Select Committee on the means of promoting the cultivation and improvement of the waste, uninclosed and unproductive lands of the kingdom, 1705.

[3] Porter's "Progress of the Nation," by F. W. Hirst, p 183.

[4] "Annals of Agriculture," 1805.